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Received: 5 September 2018 | Revised: 22 April 2019 | Accepted: 10 May 2019

DOI: 10.1111/ger.12420

ORIGINAL ARTICLE

Gerodontology WILEY

The influence of oral health status on speech intelligibility, articulation and quality of life of older community-dwelling people

Evelien Langlois[1] | Hannah Desaeyer[2] | Mirko Petrovic[3] | Kristiane Van Lierde[4] | Luc De Visschere[5]

[1]Department of Dentistry, University of Ghent, Ghent, Belgium

[2]Department of Speech, Language and Hearing Sciences, University of Ghent, Ghent, Belgium

[3]Department of Internal Medicine and Pediatrics, Faculty of Medicine and Health Sciences, Ghent University Hospital, Ghent, Belgium

[4]Department of Speech, Language and Hearing Sciences, Faculty of Medicine and Health Sciences, Ghent University Hospital, Ghent, Belgium

[5]Department of Dentistry, Faculty of Medicine and Health Sciences, Ghent University Hospital, Ghent, Belgium

Correspondence
Evelien Langlois, Department of Dentistry, University of Ghent, Ghent, Belgium.
Email: Evelien.Langlois@UGent.be

Abstract

Objective: To investigate the impact of the oral health status on speech intelligibility, articulation and quality of life of older community-dwelling people.

Background: To our knowledge, there have been no studies on this topic in patients aged 75 years or older.

Material and methods: Thirty outpatients of a university dental clinic (median [IQR] age of 77.00 [75-82] years) participated. The OHIP-14, a dental examination, a speech intelligibility study and an articulation examination were conducted.

Results: Distortions of rhotacisms and sigmatisms were most common, followed by distortions of labiodentals and apicoalveolars. Seven participants (23%) required dental treatment. Distortions of rhotacisms were lowest in participants with loss of teeth in the posterior part of the maxilla and equal in participants with edentulous maxilla and loss of teeth in the anterior part of the maxilla ($P = 0.014$). Labiodental distortions were lowest in participants with loss of teeth in the posterior part of the maxilla, but were higher in participants with loss of teeth in the anterior part of the maxilla and highest in participants with an edentulous maxilla ($P = 0.035$). People with normal mouth opening had lower percentage of labiodental distortions than people with a reduced mouth opening ($P = 0.05$). The proportion of participants with inadequate denture hygiene and distortions of bilabials was 71.4% compared to 10.5% for participants with adequate denture hygiene ($P = 0.005$).

Conclusion: Dentists must consider the impact of a denture on speech, but also should be aware of other oral health factors that influence the speech and quality of life of elders.

KEYWORDS
articulation, elders, oral health, speech intelligibility

1 | INTRODUCTION

Population ageing is a worldwide phenomenon. Ageing goes together with an increased prevalence of cognitive and/or functional disability, frailty and care dependency in older people. A high level of oral health needs is accompanied by significantly reduced oral health-related quality of life (OHRQoL) among the majority of older nursing home residents.[1-5] However, the problem of high oral health needs is both a problem among nursing home residents and the general population of older people. Several studies

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monitored the need for dental treatment among the older population, observing a very high need, especially for prosthodontic treatment.[6-8] A study from Denmark,[8] for example, observed a dental and prosthetic treatment need among 80% of older community-dwelling people.

The impact of oral health on the quality of life of the older population has been acknowledged by the World Health Organization (WHO)[9] and investigated using the Oral Health Impact Profile (OHIP-14) questionnaire.[10,11] Both oral health and quality of speech have a high impact on social contact, which is another important factor influencing the quality of life. For example, people with voice disorders might experience reduced social abilities and avoid social contact.[12,13] Therefore, one's oral health and speech are crucial to one's social life.

As the prosthodontic treatment need among older people is high, dentists must be aware of the impact of prosthetic devices on the speech capacity of patients. Chierici et al[14] describes the influence prosthodontics can have on the oral system which plays a role in the formation of speech. Subsequent studies focused on the relation between oral implant-supported dentures or removable dentures and speech intelligibility and articulation.[15-18] There were significantly more problems with speech in patients with a fixed denture compared to patients with a natural dentition or with removable dentures. However, there have been almost no studies on the association between oral health in general and speech intelligibility and articulation. To our knowledge, there have been no studies on this topic in patients aged 75 years or older.

The aim of the present study is to investigate the impact of oral health status on the speech intelligibility, articulation and the related quality of life of community-dwelling older people of 75 years or older. The H_0 hypothesis is that the oral health status has no impact on the speech intelligibility, articulation and related quality of life.

2 | MATERIALS AND METHODS

Dutch-speaking outpatients aged 75 years or older visiting the Ghent University Hospital dental clinic were included. In total, 65 older people were approached and informed about the ongoing study, of which 30 people agreed to participate. Participants were informed about the content of the study and gave informed consent. This study was approved by the Ethical Committee of the University Hospital of Ghent, Belgium (2017/1385).

2.1 | Speech assessment

Participants completed a questionnaire about their age, education level, previous speech therapy and medical history (ie allergies, use of alcohol, medication, speech and breathing problems, neuromotor dysfunction, palatal distortion, craniofacial defects, cognitive deficiency and hearing acuity), and profession. Some professions (eg elite vocal performers, professional voice users) have high occupational communication needs, and this can be a confounding variable for speech articulation. The speech intelligibility was measured using the NSVO (Nederlandstalig Spraakverstaanbaarheids Onderzoek) test and the standard Dutch text "De noorderwind en de zon." The NSVO is a standardised test which assesses the speech intelligibility on phoneme level and is divided into three parts: part A evaluates the initial consonants, part B evaluates the final consonants and part C the vocals. Speech intelligibility was evaluated by using a scale from 0 (normal) to 4 (severely disordered). The speech articulation was measured using a picture designation test according to the study of Vingerhoets et al.[19] In this test, participants must look at the picture of known objects or actions and name them. Using this test, all Dutch sounds and most consonant clusters (in initial, medial and final position) can be phonetically assessed. Finally, spontaneous speech was evaluated by having a conversation with the speech therapist and by discussing the questionnaire. The samples were recorded digitally and later evaluated by consensus analysis by two speech therapists who were blinded for the oral health status.

2.2 | Oral health examination

Participants completed the Dutch version of the OHIP-14 questionnaire to determine the oral health-related quality of life. This is a short version of the OHIP-49 and has been validated by van der Meulen et al.[20] A detailed oral examination was performed.

First, the oral mucosae were checked for the presence of aphthae, flabby ridges, pressure ulcers, exostoses, hyperkeratosis of the inner cheek, contact stomatitis, leucoplakia, cheilitis angularis, Sjögren syndrome and lichen planus. Second, the number of remaining teeth was registered as well as the mouth opening (using the 3-finger test[21,22]), the number of occlusal contacts with and without the denture (if present) excluding canines and incisors, the loss of dental hard substance by erosion, attrition and abrasion, the presence of any sharp edges in the mouth and also the locus where teeth are lost (anterior or posterior in the mandibula or maxilla). In addition, the following indices were applied: Plaque Index, Dutch Periodontal Screening Index (DPSI), Decayed-Missing-Filled-Teeth index (DMFT index) and Summated Xerostomia Index (validated by Thomson et al[23]). The latter was only measured in participants declaring a feeling of dry mouth. Finally, different prosthetic devices such as partial dentures (fixed or removable, metal frame or acrylic resin base), complete dentures (fixed or removable), bridges (one or more), crowns (ceramic or metal) and dental implants were checked. In addition to the prosthodontic status of the participant, the hygiene level, stability and retention of the prosthetic devices were also recorded. The latter variables were part of the decision to label every prosthodontic device as "no adaptation or treatment needed," "has to be renewed," "has to be repaired" or "has to be adjusted."

2.3 | Statistical analysis

Statistical analysis was performed using the software program SPSS, the Statistical Package for the Social Sciences, version 25 for Windows (SPSS Inc). Sample size was calculated using SAS Power

TABLE 1 Statistics of %distortions of different sounds. The higher the percentage, the more severe the distortion is

	%Distortion sigmatisms /s/	%Distortion rhotacisms /r/	%Distortion bilabials /w/, /b/, /p/	%Distortion labiodentals /f/, /v/	%Distortion velars /k/, /g/	%Distortion apicoalveolars /t/, /d/
Mean (SE)	20 (4.3)	29 (3.7)	2 (0.8)	5 (1.2)	0 (0.1)	2 (0.4)
Median (IQR)	8 (0.0-42.3)	25 (12.8-39.4)	0 (0.0-2.3)	5 (0.0-5.0)	0 (0.0-0.0)	2 (0.0-2.9)
Minimum	0	0	0	0	0	0
Maximum	68	72	17	29	2	9
N people	21	27	9	17	4	21

and sample size with a power of 0.8. Distribution and normality of each variable were checked using the Shapiro-Wilk test, histogram and Q-Q plot, before performing a statistic test. A significance level of $\alpha = 0.05$ was used. Associations between non-parametric variables were tested using the Mann-Whitney *U* test (two categories) and the Kruskal-Wallis test (>2 categories). Additionally, the Fisher exact test for unpaired proportions and the Spearman correlation coefficient for correlation between two variables were used. The consensus between the two speech therapists was checked using the two-way mixed intraclass correlation coefficient (ICC) with an absolute agreement and average measures.

3 | RESULTS

Thirty participants (aged 75-89 years; 20 women and 10 men) completed the study, resulting in a response rate of 46%. The median (IQR) age was 77 (75-82) years.

No abnormalities were registered by the general health questionnaires: all participants were healthy, did not have hearing problems, had no profession with high communication needs and did not have head or neck surgery yet. None of the participants had already followed speech therapy, and none had inadequate speech intelligibility. The median NSVO percentage was 92% (88%-94%) while speech intelligibility is considered "inadequate" at 50%-60%. Problems with articulation of speech were seen in every patient. Distortions of rhotacisms and sigmatisms were most common, followed by distortions of labiodentals and apicoalveolars. Statistics and distribution of distortions are represented in Table 1.

No aphthae, flabby ridges, exostoses, hyperkeratosis of the inner cheek, leukoplakia, cheilitis angularis, lichen planus or Sjögren syndrome was observed. In 16 participants dental implants were observed, nine participants wore a removable complete denture and two had a fixed complete denture. Seven participants (23%) were in need of dental treatment (four of them had pressure ulcers). The median (IQR) OHIP-14 score was 19.5 (14.0-24.25) out of 80 (maximum value). Only two participants stated that their speech problems had an effect on their quality of life.

No statistically significant difference was found between the proportion of participants with or without any disorder of articulation and DMFT, DPSI, plaque index, contact stomatitis, the type and the state of the prosthetic device, erosion, attrition, abrasion, dental implants, pressure ulcers, sharp edges in the mouth, xerostomia, the number of occlusal contacts, the location of the denture in the lower jaw and hygiene of the prosthetic device (Fisher's exact test). Statistical analysis revealed an association between the severity of articulation disorders and the state of prosthodontic device, mouth opening, dental implants, pressure ulcers, DPSI, sharp edges in the mouth and denture hygiene, respectively. These findings were, however, not statistically significant (Kruskal-Wallis, Mann-Whitney *U*; Table 2).

A statistically significant difference was found in people with distortions of rhotacisms between groups with loss of teeth in different parts of the maxilla (Fisher's exact, $P = 0.014$). Distortions were

TABLE 2 Summary of possible associations between oral health factors and distortions

	Mean (SE) %distortion sigmatisms	Mean (SE) %distortion rhotacisms	Mean (SE) %distortion labiodentals	Mean (SE) %distortion apicoalveolars	Mean (SE) %distortion bilabials	Mean (SE) %distortion velars
State of prosthodontic devices						
Has to be adjusted	25% (9.1)	30% (8.5)	6% (3.9)	3% (1.2)	4% (2.5)	1% (0.3)
No adaptation needed	19% (4.9)	28% (4.2)	4% (1.1)	2% (0.5)	1% (0.6)	0% (0.1)
Mouth opening						
Normal	17% (4.7)	26% (4.5)	3% (1.1)	2% (0.5)	1% (0.7)	0% (0.1)
Reduced	28% (9.1)	35% (6.5)	8% (3.0)	3% (1.0)	4% (1.9)	0% (0.2)
Dental implants						
Yes	15% (4.9)	31% (5.3)	3% (1.0)	2% (0.5)	1% (0.3)	0% (0.1)
No	26% (7.1)	26% (5.2)	7% (2.2)	3% (0.7)	3% (1.5)	0% (0.2)
Presence of pressure ulcers						
Yes	32% (13.1)	31% (15.1)	9% (7.0)	2% (1.0)	5% (4.0)	0% (0.4)
No	19% (4.5)	28% (3.8)	4% (1.0)	2% (0.5)	1% (0.7)	0% (0.1)
DPSI						
<3	14% (5.4)	33% (6.9)	2% (0.7)	2% (0.5)	0% (0.3)	0% (0.1)
≥3	30.0% (8.6)	26% (6.7)	5% (2.3)	3% (1.0)	3% (1.5)	0% (0.0)
Presence of sharp edges						
Yes	50% (9.8)	30% (9.2)	10% (10.4)	5% (3.4)	7% (7.0)	0% (0.0)
No	18% (4.3)	28% (4.0)	4% (1.1)	2% (1.4)	2% (0.7)	0% (0.1)
Denture hygiene						
Good hygiene	15% (5.0)	33% (5.2)	2% (0.6)	2% (0.5)	1% (0.5)	0% (0.1)
Bad hygiene	30% (9.6)	20% (4.8)	9% (3.7)	3% (0.7)	4% (2.2)	1% (0.3)

Abbreviation: DPSI, Dutch Periodontal Screening Index.

lowest in participants with loss of teeth in the posterior part of the maxilla and equal in participants with edentulous maxilla and loss of teeth in the anterior part of the maxilla (Table 3). In the same groups, a significant difference in participants with labiodental distortions was found (Fisher's exact, $P = 0.035$). Labiodental distortions were also lowest in participants with loss of teeth in the posterior part of the maxilla but were higher in participants with loss of teeth in the anterior part of the maxilla and the highest in participants with an edentulous maxilla (Table 3).

The Mann-Whitney U test ($P = 0.05$) showed that people with normal mouth opening had a lower percentage of labiodental distortions compared to people with a reduced mouth opening (Table 3). Finally, a statistically significant difference was observed in participants with distortions of bilabials between people with good or bad denture hygiene (Fisher's exact, $P = 0.005$). The proportion of participants with distortions of bilabials and inadequate denture hygiene was 71% while the proportion of participants in the group with adequate denture hygiene was 11% (Table 3).

4 | DISCUSSION

The aim of the present study was to investigate the impact of the oral health status, beyond dentures, on speech articulation, intelligibility and quality of life of community-dwelling older people. The main findings of this study were a high appearance of distortions of rhotacisms and sigmatisms in this age group and a statistically significant association between mouth opening and labiodental distortions, denture hygiene and bilabial distortions and between distortions of rhotacisms or labiodentals and three groups with loss of teeth in different parts of the maxilla, respectively. Below we interpret the associations identified in this study.

A major strength of this study is its examination of a number of oral health variables that are seldom investigated in older people. However, there are some limitations. First, the study has a small sample size which could have influenced the results. Second, this study has sampling bias as the sample was composed of people seeking for dental treatment. Finally, if participants had a dental device, they were only included if they had worn it for at least one year. However, the study did not include the time that patients have been wearing the devices as a variable.

The gender distribution corresponds approximately with the gender distribution in the Belgian 75+ population and with other studies in this age category.[1,6,7] In this group of older people, a dental treatment need of 23% was found. In comparison with other studies, this treatment need is quite low.[1,8] A possible explanation could be the small study sample (n = 30) and the sampling bias. Because of this, only older people who still are able to visit the dentist regularly

TABLE 3 Summary of statistically significant results

	Proportion of participants	95% CI	Median (IQR) %distortion	*P*-value
Rhotacism distortion and				
Loss of teeth posterior in the maxilla	63%	31%; 86%		0.014
Loss of teeth anterior in the maxilla	100%	72%; 100%		
Edentulous maxilla	100%	31%; 86%		
Labiodental distortion and				
Loss of teeth posterior in the maxilla	25%	7%; 59%		0.035
Loss of teeth anterior in the maxilla	50%	24%; 76%		
Edentulous maxilla	83%	55%; 95%		
Labiodental distortion and				
Normal mouth opening			0% (0.0-4.7)	0.05
Reduced mouth opening			5% (2.3-11.5)	
Bilabial distortion and				
Good hygiene of denture	11%	3%; 31%		0.005
Bad hygiene of denture	71%	36%; 92%		

were examined. The treatment need was not reflected in the median OHIP-14 score who was 19.5 (14.0-24.25) out of 80. Only two participants stated that their speech problems influence their quality of life, and only one patient reported that she had difficulties to perform daily activities. However, the fact that most participants are not bothered by their oral health status or speech problems does not mean that their oral health needs should go unmet by healthcare providers. The reason for this rather low OHIP-14 score could be that participants were influenced by their contemporary feeling at the time of answering the OHIP-14 questions.

A possible explanation for the high appearance of distortions of rhotacisms could be the Ghent dialect, the dialect of the city where the study was performed. The uvular fricative (r-like sound produced in the back of the vocal tract usually only using the uvula) is a typical characteristic of this dialect.[24] Because of this, it might be interesting for further research to extend the research over Flanders, which has a number of regional dialects, to verify the high appearance of distortions of rhotacisms in this age group with their oral health status. A high appearance of distortions of sigmatisms was observed accordingly to the results of Van Lierde et al[15,16] confirming a high appearance of these distortions in people with prosthodontics.

Statistical analysis revealed several significant associations (Table 3).

First, the proportion of people with distortions of labiodentals or rhotacisms was influenced by the place of loss of teeth in the maxilla. Labiodentals are formed by impelling an airflow between the teeth in the upper jaw and the lower lip while rhotacisms are made by impelling an airflow through a narrow space in the mouth. The position of the tongue is crucial: behind the upper incisors and the palatal ridges, not touching the hard palate. This could explain why participants with prosthodontic devices only in the posterior part of the maxilla had fewer distortions of those sounds. The difference between the other two groups can be explained by the type of prosthodontic device. The group with loss of teeth in the anterior part of the maxilla all had a bridge as prosthodontic device, while the participants with an edentate maxilla had removable or fixed full dentures. Several researchers have already acknowledged the influence a full denture can have on speech and have mentioned the importance of a well-designed and well-fitting full denture.[14,17,25]

Second, a significant difference in the percentage of distortions of labiodentals between a normal and a reduced mouth opening was found. Because labiodentals are formed by impelling an airflow between the upper teeth and the lower lip, these sounds can experience distortions when the mouth is inadequately opened. The mouth opening can be reduced due to temporomandibular joint dysfunction, or due to a wrong occlusal vertical dimension with prosthodontic devices. The importance of a correct vertical dimension is also confirmed in other research.[14,26,27]

Finally, the proportion of participants with distortions of bilabials was influenced by a good or bad denture hygiene. For the other sounds, only an association was shown (Table 2). Bad hygiene can have an influence on the health of the mucosae and gums in the mouth. When inflamed, these can cause pain and discomfort while wearing the denture which could be the reason why this group of participants had more disorders of articulation. However, to our knowledge, no explanation can be found in the literature about why hygiene only influences the bilabial sounds. Again, the small study sample could have influenced this result.

In conclusion, distortions are related to oral health factors, but further research in a larger study population is recommended. In daily practice, dentists must take into consideration the impact of a denture on speech, but also should be aware of other oral health factors that can influence the speech and quality of life of older people. By encouraging older people to visit the dentist annually, many oral health problems can be identified and resolved in a timely manner.

ACKNOWLEDGEMENTS

I would like to thank the Honours Program in Life Sciences for giving me the opportunity to do research this early in my education at the University of Ghent. It was a very instructive experience and one that will be useful in my following studies. Also, I would like to thank my supervisors Prof. Dr. Luc De Visschere and Prof. Dr. Kristiane Van Lierde and my co-supervisor Prof. Dr. Mirko Petrovic for their constructive advice and helping hand. The authors are indebted to Dr. Katrina Perehudoff for linguistic editing of the article.

ORCID

Evelien Langlois https://orcid.org/0000-0003-3395-7514

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How to cite this article: Langlois E, Desaeyer H, Petrovic M, Van Lierde K, De Visschere L. The influence of oral health status on speech intelligibility, articulation and quality of life of older community-dwelling people. *Gerodontology*. 2019;00:1–6. https://doi.org/10.1111/ger.12420